INTRODUCTION
X-ray fluorescence (XRF) is a form of atomic spectroscopy ideal for rapid and simple determination of the elemental composition of a material. The elements in the sample are identified by analysing the energy spectrum of the fluorescent X-ray induced by an intense primary X-ray beam.

The method is non-destructive, multi-elemental, fast and cost effective. It could be applied in a non vacuum environment, without special preparation of the sample. Archaeological and historical objects are often unique and not easily movable, thus, a portable XRF detector allows in situ analysis ideally suited for archeometric applications.

DESCRIPTION OF THE APPARATUS
The moving head assembly (Fig 1) :

The X-ray Generator
(Oxford Instruments Berne 5000 http://www.oxfordrdg.com/)

The industrial grade X-ray side window shielded tube is operated in an out-coming fluorescence radiation. The detector signal is amplified and analyzed by a multichannel recorder coupled to a micro computer via an Internet link for further analysis. Automatic processing may be done by creating a “Macro” (a list of commands that could be replayed automatically).

The moving support
The detection head, containing the detector, the X-ray tube and its power supply, is fixed on a movable platform adapted on a vertical column. The column is fixed on a cart which can move along a horizontal rail. The system is modular and both arms are formed by many plugable elements of 1m long. Four motors are fitted to the system and all displacements are remotely radio controlled. The 4 movements (X, Y, Z and θ) are independently controlled allowing a very precise positioning of the detector over a surface of many square meters (see fig. 3 and 4). The program has many options that allow, for example, to change the speed of each displacement, to automate the displacements and to control the acquisition of the data. The whole head assembly could also be rotated to look up or down allowing measurements on curved surfaces.

Two video camera, fitted on the head side, are looking at the target and help the operator in the remote positioning of the system. One of the camera looks at a large area (25 x 25 cm) and presents the observed region on a color monitor for a pre-positioning of the head in front of the region of interest.

The second CCD camera, situated closer to the target surface, observes the spots of two intersecting laser beams. By moving the head assembly back and forth, it is possible to make the two spots coincide on the point of the measurement. This keeps the distance between the head and the target to the same fixed value for each measurement, allowing easy normalization of the data.

The system is controlled by a small hand held PDA (Palm) which exchanges data with two micro computers in the system. The communication is made through a radio-frequency link at 433 MHz. The software which has been specifically written for this application, is very easy to use and allows manual or automatic control of the four motors (X, Y, Z and θ). During displacements, values obtained from captors situated on the support are continuously transmitted to the controller. This allows precise monitoring of position, speed and acceleration of all the moving parts over a large surface (5m x 3m). See fig. 3-4.

The whole system has been entirely designed and realised at the IPMAS laboratory and will soon be commercialised under licence by a private company.

The data acquisition system
The acquisition system measures the energy and the intensity of the out-coming fluorescence radiation. The detector signal is amplified and analyzed by a multichannel recorder coupled to a micro computer (Macintosh LC) running the program GasSpectra II which visualizes and analyses spectra obtained from the detector. The acquisition is made through a direct connection to an ADC1 via a PIA interface. GasSpectra supports a real time display and all activities are available during acquisitions. It has limited processing abilities but spectra could be saved on disk and retrieved easily from a remote computer via an internet link for further analysis. Automatic processing may be done by creating a “Macro” (a list of commands that could be replayed automatically).

REFERENCES

RESULTS
On fig. 5, we present two spectra obtained with our apparatus together with a PIXE spectrum. The same red colored glass target was used for each spectrum. The blue spectrum was obtained with a W anode (40kV) and the red one with the Rh anode (30kV). A important background is present in both case. For the W anode, the sensitivity is good, but L lines from W (8.33 and 8.39 keV) interfere strongly with the most preeminent K lines from Cu and Zn (two elements very important for old metal artifacts). With the Rh anode, the parasitic K lines of Rh appear above 20 keV away from the energy region of the interesting lines of most targets. For comparison, we present also a spectrum obtained with the PIXE method. The background is very low and, as there is no parasitic lines, the sensitivity is higher and lines from trace elements are more easily detected.